Biodeterioration of *(Foeniculum vulgare mill*.) Seeds during storage by Fungi

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Abstract: Fennel (*Foeniculum vulgare mill*.) is an important seed spices in India at commercial level. India is a largest producer and consumer of Fennel seeds. Improper storage make the seeds vulnerable to storage fungi which deteriorate the stored seeds both quantitatively and qualitatively which is unfit for consumption. The experiment were undertaken to understand deteriorative changes. Seeds were analyzed for seed mycoflora by employing Blotter paper method and agar plate method Species belonging to different genera of fungi were isolated. Physical parameter like moisture content and loss in seed weight and dry ash content chemical parameter such as protein content by Lowry's method, free fatty acid by Zenely and colmen, iodine number and saponification value by A.O.A.C. method were explored., *Aspergillus flavus, Aspergillus niger, Fusarium moniliforme spp*. And *Rhizopus spp.* these fungi are dominate and responsible for deteriorate changes of seeds

Keywords: Mycoflora, Biodeterioration, storage seeds, *Foeniculum vulgare mill*.

INTRODUCTION

Fennel (*Foeniculum vulgare mill*) is an important spice crop in India that plays a significant role in the national economy. It is cultivated on a commercial scale in various countries including Russia, Romania, Italy, France, Argentina, the USA, and India. In India, fennel is extensively cultivated in Gujarat, Rajasthan, and Uttar Pradesh (Northern India as a cold-weather crop), and to a lesser extent in Tamil Nadu, Bihar, Maharashtra, Karnataka, Jammu & Kashmir, and Punjab. Fennel seeds are obtained from the herb Foeniculum vulgare, which is native to Southern Europe and the Mediterranean region (Cleveya et al., 1997), and belongs to the family Apiaceae. The seeds are oblong, small, cylindrical, and greenish-yellow in color.Studies on fennel cultivars revealed seed-associated mycoflora including *Aspergillus flavus*, A. *niger*, *Rhizopus stolonifer*, *Cladosporium cladosporioides*, and *Curvularia lunata* (C. lunatus). These fungi were found to cause seed infections, leading to reduced seed viability. Among them, seed viability was most significantly reduced by A. flavus, while R. stolonifer caused minimal infection and the least reduction in viability (Kumar and Kumar, 2001). A similar study conducted on 127 seed samples of *Foeniculum vulgare* from Rajasthan also reported the presence of Aspergillus and *Curvularia* species. Fungal Biodeterioration of fennel seeds is a major concern during storage, as it affects seed quality, flavor, and safety due to microbial contamination and mycotoxin production. Fungi such as *Aspergillus*, *Fusarium moniliforme*, and are primarily responsible for these deteriorative changes, leading to discoloration, odor, and nutrient loss. Research has shown that the antifungal properties of fennel essential oils and other treatments can help mitigate fungal growth and contamination.

METHODS AND MARTIALS

Collection of sample: The seeds samples were collected from market places retailer shops and godowns of Aurangabad .Maharashtra

Isolation and Identification of Seed Mycoflora: Isolation of seed mycoflora was performed using the blotter method (De Tempe, 1953), agar plate method (Muskett, 1948), and seed washing method Neergaard (1977). Isolated fungi were identified based on colony morphology and microscopic examination of mycelia and spores(D.S Mukkadam)

Biodeterioration and Biochemical Analysis: To evaluate the extent of Biodeterioration, various physical and chemical parameters were assessed. Moisture content were determined as per standard methods (Neergard, 1977; AOAC, 1947). Protein

content was estimated by Lowry's method (Lowry et al., 1951), total oil content by Meara (1955), free fatty acids by Zenely and Coleman (1938), and iodine number and saponification value were measured according to AOAC (1960).

Table 01: Seed mycoflora associated with fennel seeds by Agar plate, Blotter paper and seed washing method

No.	Name of Fungi	Blotter Method	Agar Plate Method	Seed Washing Method
1	*Aspergillus flavus*	+	+	+
2	*Aspergillus niger*	+	+	+
3	*Aspergillus fumigatus*	+	+	+
4	*Aspergillus ochraceus*	-	-	+
5	*Alternaria alternate*	+	+	-
6	*Alternaria brassicicola*	-	-	-
7	*Cladosporium cladosporioides*	+	+	+
8	*Colletotrichum spp*	-	-	-
9	*Curvularia lunata*	+	+	-
10	*Chaetomium globosum*	-	-	-
11	*Drechslera spp.*	+	+	+
12	*Fusarium moniliforme*	+	+	+
13	*Fusarium oxysporum*	-	-	-
14	*Fusarium solani*	+	+	+
15	*. Mucor spp.*	-	-	+
16	*Penicillium citrinum*	+	+	+
17	*Penicillium chrysogenum*	-	+	+
18	*Phoma spp*	+	+	-
19	*Rhizopus stolonifer*	-	-	+
20	*Trichoderma harzianum*	+	+	-

Figure shows the mycoflora associated with fennel seeds

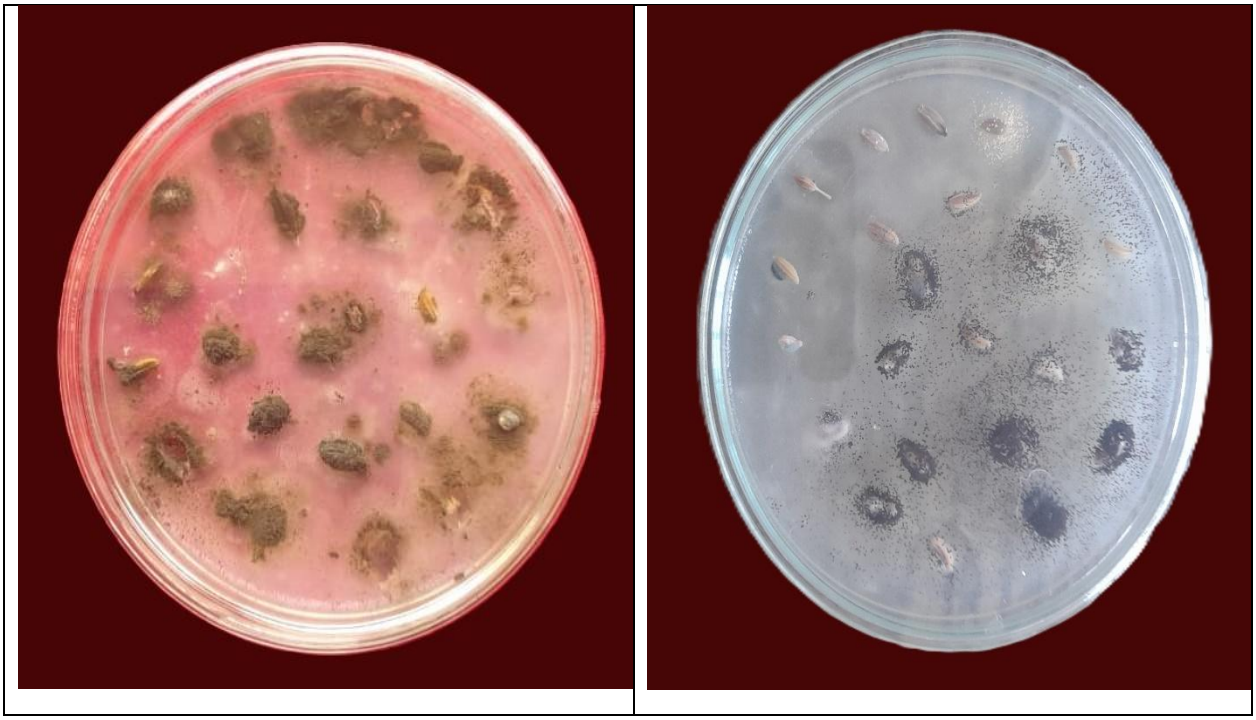

Table 02 shows: Physico chemical parameters for healthy and infected seeds of fennel

Parameter	Healthy fennel seeds	Infected fennel seeds by *Aspergillus flavus*	Infected fennel seeds by *Aspergillus niger*	Infected fennel seeds by *Fusarium moniliforme*
Moisture content %	9.0	11.0	11.0	12.8
Ash content %	6.0	6.5	6.8	7.2
Oil content %	18.0	15.0	14.8	13.5
Protein content %	19.5	16.0	15.2	14.0
Iodine value	105	90	85	80
Saponification value (mg KOH/g oil)	195	185	180	175
Free fatty acid %	0.4	1.2	1.8	2.5

RESULTS AND DISCUSSION

The data presented in Table 02 highlights the impact of fungal infection on the physico-chemical quality of fennel seeds. A comparison between healthy seeds and those infecte *Aspergillus flavus, Aspergillus niger*, and *Fusarium moniliforme* reveals notable deterioration in key quality parameters.

Moisture content significantly increased in infected seeds, with the highest recorded in seeds infected by Fusarium moniliforme (12.8%), compared to 9.0% in healthy seeds. This increase in moisture creates favorable conditions for fungal growth and further microbial colonization.

Ash content, which indicates the total mineral content, also increased slightly across infected samples. The maximum was observed in Fusarium moniliforme-infected seeds (7.2%), suggesting possible metabolic changes in mineral composition due to fungal activity.

Oil content showed a marked decline in infected seeds, from 18.0% in healthy samples to 13.5% in seeds infected by Fusarium moniliforme. This reduction could be attributed to the breakdown of lipids by fungal enzymes, affecting both quantity and quality of the oil.

Protein content also decreased progressively with fungal infection. Healthy seeds recorded 19.5% protein, whereas seeds infected with Fusarium moniliforme showed only 14.0%. Fungal metabolism and enzymatic degradation may have contributed to the reduction of nitrogenous compounds.

Iodine value, which reflects the degree of unsaturation in fatty acids, decreased from 105 in healthy seeds to 80 in those infected by Fusarium moniliforme. This decline indicates alterations in fatty acid structure and potential oxidative rancidity.

Saponification value, a measure of molecular weight of fats, also dropped from 195 in healthy seeds to 175 in Fusarium infected ones. This suggests the breakdown of higher molecular weight triglycerides into simpler compounds due to microbial activity.

Free fatty acid (FFA) content, an indicator of oil rancidity, increased significantly with fungal infection. FFA rose from 0.4% in healthy seeds to 2.5% in Fusarium moniliforme-infected seeds. This increase confirms lipid degradation and poor seed/oil quality resulting from fungal action.

In summary, fungal infestation adversely affects the nutritional and storage quality of fennel seeds. Among the tested fungi, Fusarium moniliforme caused the most severe deterioration, followed by Aspergillus niger and Aspergillus flavus. The findings emphasize the importance of proper storage and fungal management to maintain the physico-chemical integrity of spice seeds.

CONCLUSION

The study clearly demonstrates that fungal contamination significantly compromises the quality of fennel seeds during storage. Infected seeds exhibited increased moisture and ash content, along with a marked reduction in oil and protein levels, iodine value, and saponification value. The elevated free fatty acid content in infected samples further confirms deterioration in seed and oil quality. Among the tested fungi, *Fusarium moniliforme* had the most

detrimental impact, followed by *Aspergillus niger* and *Aspergillus flavus*. These findings highlight the urgent need for effective fungal control strategies and proper storage conditions to preserve the nutritional and commercial value of fennel seeds.

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